Amendments to the Specification

Please replace the paragraphs at page 3, line 20 through page 7, line 20 with the following amended paragraphs:

Referring now to FIG. 1, there is shown an arrangement for replacing an active echo canceller with a redundant echo canceller. An input telecommunication ~~signals~~ signal, such as an E1 32-channel PCM multiplexed signal, is received by a system controller 10 along input line 12, and is processed for echo cancellation. The processed signal is transmitted from the system controller 10 along line 14. During normal operation of a primary echo canceller module 16, the system controller 10 routes the inbound PCM signal to the echo canceller module 16 and receives the processed PCM signal from the echo canceller module 16 along line 18. Control signals between the system controller 10 and the echo canceller module 16 are communicated along line 20.

The echo canceller module 16 includes a system interface 22 for receiving and transmitting respective PCM and control signals to and from the system controller 10, an echo logic interface 24, an echo canceller unit 26 implemented as an application-specific integrated circuit (ASIC), and a CPU 28 for coordinating the functions of the echo canceller module 16.

The echo canceller unit 26 is shown in greater detail in FIG. 2. In a preferred embodiment, the echo canceller unit 26 is configured for processing a 32 channel outbound signal, received at send-in terminal SI. The processed signal is provided at send-out terminal SO. The inbound telecommunication signal is received at receive-in terminal RI, and passed to a receive-out terminal RO. A tone-disabler circuit 60 is connected with the RO terminal and is configured for detecting an echo canceller disabling tone in any of the 32 telecommunication channels. The tone-disabler circuit 60 maintains a 32 bit status register for storing the current echo cancellation status (enabled or disabled) for each of the channels. The tone-disabler circuit 60 continuously transmits the contents of its status register as a serial signal via a tone-disable bypass signal terminal (TD_Bypass). Each PCM data channel for which echo cancellation is disabled passes from the SI terminal through a send path bypass register 62 to a multiplexer [[64]] 65. Each PCM data channel for which echo cancellation is enabled passes from the SI

terminal through echo filter 64, and then to multiplexer [[64]] 65. The signals provided to multiplexer [[64]] 65 are arranged in proper time-division sequence, and then provided at the SO terminal. An Overall Bypass terminal is provided for receiving an external serial signal effective to bypass echo cancellation within the echo canceller unit 26. The Overall Bypass signal controls operation of the multiplexer [[64]] 65 in order to select the unprocessed send-input signal or the echo canceled signal, and to pass the selected signal to the SO terminal.

Referring again to FIG. 1, the echo logic interface 24 is configured to receive the TD_Bypass signal from the echo canceller unit 26 and store the TD_Bypass signal in an internal 32 bit register. The echo logic signal produces the Overall Bypass signal by performing a logical OR upon the received TD_Bypass signal, and an alternative bypass signal generated by CPU 28. The Overall Bypass signal is clocked to the echo canceller unit 26 at the channel time-division rate. In this manner, echo cancellation on each of the channels is determined by the TD_Bypass signal and by the alternative bypass signal, so that the CPU 28 can direct that echo cancellation be disabled on any channel independently of the tone disabler circuit 27 of the echo canceller unit 26.

During operation of the echo canceller module 16, the CPU 28 maintains a record of the echo cancellation status of each channel. Whenever the echo cancellation status of a channel is changed, the CPU 28 transmits a message to the system controller 10, via system interface 22, indicating such a change, so that the system controller 10 maintains an independent record of the present state of echo cancellation on each channel.

The system controller 10 may be configured to detect a fault in the operation of echo canceller module 16 and to replace echo canceller module 16 with a redundant echo canceller 36. Additionally, the system controller 10 may perform replacement of the echo canceller module 16 in response to an external signal received along control line 31. The redundant echo canceller module 36 is connected to the system controller 10 via PCM communication line 34 and data communication line 32. The redundant echo canceller module 36 is similarly configured as echo canceller module 16 and includes a system interface 42, an echo logic interface 44, an echo canceller unit 46 that includes a tone-disabler circuit 47, and a CPU 48. When the system controller 10, whether independently or in response to an external control signal, initiates

replacement of module 16 with module 36, the system controller 10 maintains transmission of the PCM and control data to the module 16, and begins to transmit the same PCM and control data to module 36 in parallel. This parallel transmission may commence asynchronously with the transmission frame timing of the E1 PCM signal, and allows the module 36 to initialize and stabilize. Additionally, the present status of echo cancellation enablement, as stored by the system controller 10, is transmitted to the redundant module 36 and written into the status register of the echo logic interface 44 of the redundant module 36. At the next frame edge of the E1 PCM signal, or at a subsequent frame edge, the system controller 10 internally switches the outbound PCM signal line 14 to transmit the processed PCM signal from the redundant echo canceller 36. In this manner, the redundant echo canceller 36 is brought into operation having the same echo cancellation status as was present on each channel in the primary echo canceller 16 at the time that a replacement condition was indicated.

It will be appreciated that additional information pertaining to the operation of the primary echo canceller can be monitored by the CPU 28 thereof, transmitted to the system controller 10 during operation, and used to initialize operation of the redundant echo canceller 36. The method described above provides for bringing a redundant echo canceller 36 online while preserving the cancellation status of each channel. In a further adaptation of this method, the CPU 28 of the active echo canceller 16 may be configured to receive other state information from the echo canceller ASIC 26 thereof. For example, the echo canceller ASIC 26 may be configured to perform additional or alternative signal processing operations such as audio enhancement, code conversion, compression, and the like. In such an embodiment, the CPU 28 may monitor and transmit to the system controller 10, the present status of such additional or alternative signal processing operations. Hence, it will be appreciated that echo cancellation, as discussed above, is but one of a variety of signal processing operations that may be performed on the ~~telecommunications~~ telecommunication signal channels. Furthermore, the CPU 28 of the echo canceller unit 16 may monitor and transmit to the system controller 10 such additional state information as the present state variables defining the impulse response and/or time delay parameters utilized to perform echo cancellation within each channel. In this manner, the redundant echo canceller 36 may be activated and brought online with no adaptation delay

required to obtain accurate echo cancellation within each presently operating channel of the telecommunication signal.